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ABSTRACT

This paper describes the reasons for development and implementation of planning management systems in institutions of higher education, relates the history and significance of the Western Interstate Commission for Higher Education Planning and Management System (PMS) program, and compares 2 approaches to implementation. It is suggested that a gradual or evolutionary approach to implementation is preferable to a large-scale design and implementation program in order to gain the benefit of training and early experience. The 6 suggested beginning steps are: executive training, development of an analytic capability, implementation of program cost accounting, application of a resource requirement model, application of a student flow model, and selection and implementation of a scheduling model. The first 2 steps are necessary to develop executive capability and confidence in the planning technology. Cost accounting is a prerequisite to almost all other analytic efforts. Implementation of the 2 models is recommended to gain a better understanding of the institution's underlying processes. (Author)

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James Farmer

Division of Analytic Studies

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Preface

The growing interest in management information systems, analytic studies programs, program budgeting, and other planning and management systems developments by institutions of higher education, has generated a growing discussion of the problems of implementation. This paper is intended as a partial response to the many inquiries which have been received by the Chancellor's Office.

While the paper reflects the experience of the California State Colleges, it also represents the experiences and opinions of many individuals participating in similar developments at other institutions. The California State Colleges are pursuing an evolutionary approach to development of a management information system similar to the plan suggested in this paper. They have received legislative direction to implement the Western Interstate Commission for Higher Education (WICHE) Planning and Management System (PMS) and will use many of the WICHE products.

The views expressed in this paper should not be interpreted as reflecting the views or policies of the California State Colleges.

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The author appreciates their generous assistance, but remains responsible for the content and opinions expressed in this paper.

Abstract

This paper describes the reasons for development and implementation of planning management systems in institutions of higher education, relates the history and significance of the Western Interstate Commission for Higher Education (WICHE) Planning and Management System (PMS) program, and compares two approaches to implementation. It is suggested that a gradual or evolutionary approach to implementation is preferable to a large-scale design and implementation in order to gain the benefit of training and early experience before committing to full-scale implementation. The six beginning steps suggested are:

Executive Training
Development of an Analytic Capability
Implementation of Program Cost Accounting
Application of a Resource Requirement Model
Application of a Student Flow Model
Selection and Implementation of a Scheduling Model

The first two steps are necessary to develop executive capability and confidence in the planning technology. Program cost accounting is a prerequisite to almost all other analytic efforts. Implementation of a resource requirements model and a student flow model is recommended in order to gain a better understanding of the underlying processes of the institution.

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AN APPROACH TO PLANNING AND MANAGEMENT SYSTEMS IMPLEMENTATION

Interest in Planning and Management Systems

College administrators, public officials, and institutional governing boards have shown considerable interest in the development of planning and management systems for higher education. College administrators are desperately trying to meet the demands for higher education with the available resources, and hope these systems will give them additional insight and practical assistance. Public officials, frequently critical of the spiraling costs of higher education (which are rising much faster than the Gross National Product) would like some assurance that colleges and universities are being well-managed--that they meet the tests of stewardship of other publicly funded agencies. This change in attitude has been brought on partly by the shortage of funds for the many social programs and public services needed today, partly by the potential "over-production" of specialists by colleges and universities, and partly by a widespread questioning of the role and purpose of higher education. As one result, many officials--including governors, legislators, and heads of funding agencies--have developed an interest in planning and management systems, and in one case--California--the WICHE Planning and Management System has become mandatory for the public institutions of higher education.*

Independent colleges and universities are not exempt from the new level of scrutiny. The recent Carnegie report on higher education's

*Ref. 1, page 368 and 450-451.

financial problem cites the need for all institutions to be "reasonably governable."* In other words, a climate of stewardship is necessary to establish and maintain a platform for support other than enrollment growth. For the private colleges, philanthropy and potential state and federal assistance will be influenced heavily by the character of management in those institutions.

But college administrators, having heard so much about planning and management systems development, may wonder how such a system can become operational on their campus. The practical problems of implementation are not easily solved. Several approaches may be used. An institution may hire a consulting firm to develop a system, train the staff, and assist in the system's operation. This approach would be expensive since it would, at this time, require a significant independent development effort. An evolutionary approach may be preferable. Such an approach would begin by training staff, modifying the operational data bases, and implementing some planning tools as they become available through cooperative efforts with other institutions, from supported research programs, or the experiences of other institutions.** Before outlining this gradual approach, it may be useful to review the development of the components of planning and management systems.

While the components of these systems are not particularly innovative, neither are they direct applications of similar techniques from business or government. Higher education is a much more complex

*Ref. 2

**The Ford Foundation is supporting such programs at the University of California, University of Georgia, University of Toronto, and WICHE: USOE is supporting WICHE, the R&D centers and Regional Laboratories, and some specific projects at other institutions.

process than manufacturing, defense, or even social welfare programs. Higher education contributes to the individual through the economic and personal benefits of his education; to society through the social and economic benefits derived from an educated population; and to business through the results of research and the availability of trained personnel.* The product of higher education, whichever aspect chosen, is not the unique result of classroom instruction, laboratory periods, research assignments, or even the environment provided by libraries, student activities, computers, or plant facilities. Rather, the product is the result of all of these inputs integrating in a complex and, perhaps, immeasurable way. Recognizing the unquantifiable aspects of the education process, some educators have been rightfully concerned with the issue of preserving its essence while applying planning technology to higher education.

So far, the development of PMS components has centered on extensions and adaptions of the available technology. Institutions first focused on particular local problem areas: for example, Michigan State and the University of Illinois on space and facilities; the University of California on cost prediction; the University of Texas on program budgeting; the University of Wisconsin on enrollment projections; SUNY on student flow, and Purdue on scheduling. Although some attempted to form "cooperate projects," most were conducted in virtual isolation. There

*For a discussion of the outputs of higher education, see Ref. 3

was no national effort, no professional organization, no cooperative networks, and no publications which would have made the effort less redundant and, perhaps, more productive. The various foundations and funding agencies could not provide an integrated development plan. And there was no constituency--no demand by institutions, no motivating interest by state governments, and no public appreciation of the coming financial problems of higher education.

The WICHE Management Information Systems project was the first effort to attract national interest. Their task forces became a focus of inter-institutional exchange of information, while their publications and training seminars identified the useful work occurring throughout the community. The Legislative Workshop activity of WICHE (for the 13 member states) focused attention on this PMS development effort. WICHE attempted to build a consensus of direction, and attempted to serve the demands of institutions. Planning and management systems was an idea whose time had come, and WICHE has become the focus of this activity. WICHE PMS was providing a needed national outlet for the desire of the higher educational community to build its own problem-solving capabilities.

Planning and Management System Defined

It is tempting to describe a planning and management system as a number of related computer programs.* But that definition is no longer sufficient even for operational data systems, which must include the supporting procedures, the manuals and forms, and the reports which interface the system with its users. But even this description is too restrictive for a planning and management system. It must include the decision-makers' training, the analytic staff, and institutional procedures which support planning. A planning and management system may be considered to have four basic components: trained decision-makers, analysts, analytic tools, and operational data bases.

The products of such a system are valueless unless decision-makers shape their development and are trained and committed to use the results. To be useful, presidents, vice-presidents, business managers, and deans must understand the concepts, methods, and potential results. Without this understanding, decisions cannot be improved, and there is no value and a rather significant cost to the effort. The improvement in planning does not come from the results of a single computer run, but from the continuous application of these methods by the decision-makers.

Major organizational changes may occur as planning and management systems become accepted. College and university officials will

*For a general discussion of management information systems in higher education, see Ref. 4. A more technical discussion is given in Refs. 5 and 6.

have to develop a skill and understanding of their use. A new breed of managers may emerge--executives who are comfortable with the new planning technology and who can communicate with government officials, trustees, and institutional administrators using the new concepts. Anything less may be considered "poor management."

Analytic studies units of specialists in quantitative analysis may supplement or replace traditional academic planning or budget planning. Such units will assist the executive in his major responsibility--long-range planning.

Responsibility can be more effectively decentralized as it becomes possible to estimate performance and monitor the use of resources. Planning will receive more high-level attention as day-to-day decisions are delegated to appropriate levels. This may let higher education become more responsive to the needs and concerns of students, faculty and community, through both better planning and delegation of authority.

The planning technology requires analysts to serve as the communications link between the decision-maker and the data. It is easy to forget that an analyst is necessary to operate a model and interpret the results. Such analysts must have a thorough understanding of the technology and of higher education: both are necessary, neither is sufficient.

A significant number of analytic tools are becoming available. Every analyst has had experience with the standard mathematical and statistical tools, but because of the complexity of higher education, these tools must be augmented with special models. Because of the complexity and size of these models, usually they must be computerized. WICHE is adapting or developing several such models: A Resource Requirements Prediction Model (RRPM) to give the needed levels of faculty, space and budget for a specified enrollment by major; a student flow model which predicts enrollment by level and major based on previous enrollments and admissions; a cost allocation model used in conjunction with specified cost methodologies to allocate support program costs to primary program costs and produce program and unit costs; and a program classification structure which can be used to classify input resources and outputs.* These models are being used by institutions for planning, by state governments for institutional reporting, and by the national government for data collection and statistical reporting.

Such analytic tools in turn depend on an operational data base--data developed from the day-to-day operation of a college or university. Much of these data come from the accounting system, student records, and faculty and staff files. They must be supplemented by space and facilities data, output measures, census data, and general social and economic variables in order to use the planning models described previously. Most of the data required

*Similar models are described in Ref. 6, pp. 10-28. The Program Classification Structure is given in Ref. 7.

for analytic models can be obtained as a by-product of computerized accounting, student records, and personnel systems if these needs were considered during their design. In order to produce analytically useful data, the data systems must have an underlying conceptual organization.

Future Planning and Management Systems

It is worthwhile to consider the future of planning and management systems in weighing the value of current implementations. Clearly, such concepts as space utilization, student demand (for courses), faculty activity, and degree productivity are simply too useful to be ignored. These concepts will be refined and applied on a continuous basis. Future management information systems will be expanded to produce the measures on a routine basis; data files will be developed with common data elements and definitions, computer models will be used to relate and evaluate these data by a fixed schedule; and such indices of performance as those mentioned will be periodically produced and reviewed.

Planning will be changed from an uncertainty about what lies ahead into a systematic search for and evaluation of new alternatives. Educational research can provide new teaching techniques, research management may suggest new approaches to research, and new facilities will provide opportunity for new approaches to college organization and functioning. The planning and management system will both provide

tools for these efforts and evaluation techniques for assuring that the institution, in operation, follows the planning.

It is interesting to note that the student will probably find much more freedom and faster progress under this kind of planning. As the institutional objectives become more clearly defined, increased emphasis will be placed on encouraging the student to achieve his objectives using a minimum of time and resources. Students will be given information on their expected progress using the alternatives available to them. (One of the by-products of studying the institution is learning about the factors affecting student progress, now unintentionally kept secret from the student.)

These new systems may place a video screen on every executive's desk, and make information available instantly. New plans may be evaluated by simply keying in a few changes to the data base and observing the modeled results on the video screen. Should these developments actually occur, they will be the result of significant cost reductions on the part of the computer industry--not because they are necessary to the planning process. The definitive factor is not the hardware, but a style of management--or perhaps even a state of mind.

A Basic Implementation Plan

If the future lies with automated information systems composed of complex models developing indices of performance where data is immediately available--like airlines reservations systems,

for example--is it then worthwhile to begin to implement a planning and management system now, before the complete system is feasible? The answer appears to be yes, for a number of reasons. First, the conceptual insight into the process of higher education, particularly into the underlying economics is itself of significant benefit to the executive staff. Second, as long as planning and management systems exist and are used by other private and public institutions, it is important to understand their methods, costs, and results. Third, these systems provide techniques and procedures for effective long-range planning, and can better cope with abrupt changes in policy, budget, or environment. Since the first steps of implementation are comparatively inexpensive, a decision on the appropriate investment in major systems can be delayed while first-hand experience in the benefits and costs of such a system is being obtained.

The first step in implementing a basic planning and information system is the training of the executive staff. The decision-makers should have an understanding of the components, the process, and the tools. This training should explore the potential benefits, methodology, and costs of the system itself. Perhaps the best training course for higher education is the WICHE PMS Training Seminars.

The 1970 series emphasized program classification structure and program cost accounting. Participants used a small computer

model--MICRO-U 70.1--as a training aid.* The 1971 series will include new materials and a training version of the Resource Requirements Prediction Model. The National Association of College and University Business Officers (NACUBO) also sponsors seminars in planning systems. Many planning seminars by commercial firms or national associations are useful for general information, but do not consider the specific context of higher education or discuss the specific analytic tools which are available. The major accounting and consulting firms will prepare a tutorial series particularly designed for specific institutions.

Any such general training program should be supplemented by staff discussion sessions lead by a consultant discussing the specific approaches and problems of the institution. These sessions allow discussion of local implementation problems, permit staff to begin to coordinate their efforts on a project which requires participation throughout the institution, and offer the expertise of one who has had practical experience in implementation.

The second step is locating analysts for the implementation. Frequently these individuals are available within the organization (particularly in information systems or institutional research, or the business or economics faculty). It is important that the selected analysts have a knowledge of both planning technology

*The Training Model is described in Ref. 8; the training materials are available from the Western Interstate Commission for Higher Education.

and the institution of higher education. Each one should have experience in higher education and, preferably, experience in implementing quantitative planning models in organizations. Some individuals may require additional training, and time should be allocated for the group to organize and do basic research in the field.

The third step, which should not occur before the executive staff has had specific training in planning and management systems and the analytic staff has begun to function, is to develop operational data bases. The first data base is usually the accounting system. If the institution has followed current accounting practices for higher education, only minor modifications to the accounting system are required. Usually this means adding sufficient accounts to permit cost accounting at the department level.* It does not mean a significant departure from current "good practices." Rather, it is better to use an account crossover and historical analysis. After the institutional accounting system has been extended to provide department-level accounts, a program cost accounting structure should be selected. Most institutions are now considering the WICHE Program Classification Structure which is, in turn, based on the HEGIS Taxonomy of Academic Specialities.

Using the WICHE PCS provides cost by program for the primary programs--instruction, research, and community service--and the

*See Ref. 9 for recommended accounting practices.

support programs--academic support, student support, institutional support, and independent operations. If judged feasible from the supporting data for the type of costs desired, the program costs can be transformed into such unit costs as degree costs, annual student costs by major, and fully-allocated research project costs.*

In order to support these costing methodologies, data must be obtained on students, faculty, space, and facilities. Specifically, it is necessary to know output proxies: degrees by type and discipline area, course demand by student level and major (usually in the form of an induced course load matrix), faculty activity by weekly student contact hours, credit hours or courses, space utilization by discipline and by type, use, faculty utilization by instruction and research, and enrollments. Most computerized student records, personnel, and space and facilities systems can be modified to provide this information. Some of it--like utilization data--can be computed by hand for small institutions, or estimated from existing data.

Thus, data from the operational data bases are used to develop unit costs by resource. The utilization of the basic resources, faculty, space and facilities, and budget can be related to the output proxies and, indirectly, to the objectives of the institution. Even though it may not be possible to quantify the outputs of the institution, and there may be some concern about using output

*For a discussion of program budgeting in higher education, see Refs. 10 and 11. For a detailed presentation of cost analysis, see Ref. 12.

proxies, the identification of resources related to a specific program can be quite valuable. The results of this analysis alone will provide significant insight into the underlying processes.

While it is readily apparent that an identification or accounting of resources would be one of the first analyses, the choice of subsequent steps is somewhat more arbitrary. It seems that a natural progression would be the installation and use of a model previously developed and used at other institutions. This course would provide a history of implementation and of results.

For this reason the suggested fourth step should be implementation of a Resource Requirements Prediction Model--a specific analytic tool. Using the term RRPM generically, rather than in reference to the specific WICHE models, the ability to estimate the requirement for faculty (by discipline, specialty, and rank) and budget as a function of enrollment can be an important planning tool. The WICHE RRPM also gives space requirements--but these can frequently best be calculated outside the model.* The RRPM can be used in several ways: predicting budget levels over a 5 to 10-year period, evaluating alternate enrollment policies, evaluating changes in teaching policies and methods of instruction, and predicting the effects of changes in student demand for specific majors. Most such models use statistical regression techniques on historical data for the prediction equations, but

*For a preliminary description of the WICHE RRPM see Ref. 13. It was based on work done by George Weathersby for the University of California (Ref. 14).

these values can be changed to evaluate alternate policies. Typical output is faculty by rank and discipline (or department), library volumes or budget, and overall estimation by category.

For similar reasons, the suggested fifth step would be implementation of a student flow model. Several such models currently under development will be useful for long-term projections of institutional enrollment and short-term projections of enrollment by department within the institution. Most of these models are based on the Markov model of students "transitioning" from one state (typically, level and major) to another. Present enrollment projections owe much of their accuracy to the practice of establishing enrollment ceilings (creating a self-fulfilling prophecy)--they fail to account for or to estimate an unsatisfied demand. Since student preferences (between majors and courses) and performance (particularly length of time in the institution) are major factors in determining the resources required for an institution, student flow models will become an important planning tool.

Since class size and space utilization are the two most important determinants of cost, matching these resources to student needs is critical. For this reason, the suggested sixth step would be development and implementation of a scheduling model. Several scheduling models are available. Choice depends on institutional policy: student demand for courses may be used to schedule students into rooms and

faculty into teaching assignments, or faculty preferences may be matched with rooms, students scheduled into the rooms, and so forth. Since scheduling significantly affects faculty and students and the utilization of faculty, space, and facilities, scheduling models may be required in order to provide a planning tool for the immediate allocation of available resources. Frequently, institutions which automate student registration fail to recognize that the selected scheduling algorithm can vary utilization costs by large amounts. Selection of a scheduling model should occur, however, after there has been experience with unit costs, output measures, and student flow--thus giving the institution a better understanding of the different kinds of scheduling policies and the effects on the institution of scheduling models which incorporate these policies.

The basic planning and management system consists of people, technology, and tools. The specific tools described here have been:

Program Cost Accounting (with unit costing)

Resource Requirements Prediction Model

Student Flow Model

Scheduling Model

These tools, with trained decision-makers and supporting analysts, comprise the basic system. The tools are available to institutions--development is not required--but the ability to use these tools is the result of a training program. An

investment, however, is required. Data collection to support these models and their implementation can be expensive, and the results can be disappointing without careful planning of the system itself.

Summary

The new planning technology for higher education is being made available through cooperative efforts such as WICHE, institutional developments, and supported planning activities. An institution should neither make a large investment in development and implementation of a single turn-key system--the future design of PMS is too uncertain and the costs too great--nor ignore the current developments. Rather, it appears preferable to make a gradual investment in PMS in order to effect early return. Even without an operable system, training will produce better decisions and will provide the knowledge and judgment necessary to guide an implementation effort. The implementation itself begins with some modification of the accounting, the student records, the personnel systems, and space and facilities inventory in order to produce unit costs by level and discipline. These data are useful not only for direct decision-making, but also provide basic input for the Resource Requirements Prediction Model and the Student Flow Model. These two models give additional insight into the processes of the institution, and provide a basis for selecting a scheduling model to implement the policies suggested by the output of the other models.

Other planning and analytic tools will become available. Some will be particularly useful for specific institutions, others may have general utility. But the present state-of-the-art suggests that RRPM and the student flow model will be the best beginning tools for planning. A significant amount of work remains in developing costing methodologies, but it is fundamental to planning. New developments and uses of planning and management systems suggest that an investment would be beneficial to most institutions, even if only for the value of executive staff training.

The models described provide a programmatic paradigm of a fairly traditional institution. The issues which can be explored lay a groundwork for extensive institutional analysis and can be modified for the unique characteristics of a specific institution. Knowledge of the resource impact of academic programs becomes only an initial benefit. A much longer term benefit comes from the systematic search for improvement.

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